

Development of international learning outcomes for shelter medicine in veterinary education: a Delphi approach

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Abstract

Shelter medicine is a veterinary discipline of growing importance. Formally accepted as a clinical specialty in the USA in 2014, the practice of shelter medicine worldwide is expanding. As a topic in veterinary pre-registration (undergraduate) education, it is frequently used as an opportunity to teach primary care skills, but increasingly recognized as a subject worthy of teaching in its own right. The aim of this study was to use a Delphi consensus methodology to identify learning outcomes relevant to shelter medicine education.

Shelter medicine educators worldwide in a variety of settings, including universities, non-governmental organisations and shelters were invited to participate. Participants were initially invited to share shelter medicine teaching materials. These were synthesised and formatted into Learning Outcomes (LOs) based on Bloom's taxonomy and organised into five subject-specific domains.

Participants were then asked to develop and evaluate the identified LOs in two rounds of online surveys. Consensus was determined at >80% of panellists selecting "agree" or "strongly agree" in response to the statement "please indicate whether you would advise that it should be included in a shelter medicine education program" for each LO. In the second survey, where re-wording of accepted LOs was suggested, preference was determined at >50% agreement.

Through this method, 102 agreed LOs have been identified and refined. These LOs, as well as those which did not reach consensus, are presented here. These are intended for use by shelter medicine educators worldwide, to enable and encourage the further development of this important veterinary discipline.

Key words: veterinary shelter medicine, Delphi method, international learning outcomes, veterinary education

Introduction

Shelter medicine is one of the newest disciplines within veterinary medicine, recognized as a specialty by the American Board of Veterinary Practitioners in the USA in 2014 (1). Internationally, this field is widely practiced and of increasing importance.

Shelter medicine describes the veterinary care and management of unowned animals in shelters or other rehoming establishments. The practice of shelter medicine is wide-ranging and includes many aspects of physical and behavioural health of animals in shelters, epidemiology, population dynamics, high quality clinical decision-making, resource management and reducing companion animal homelessness (2, 3).

Shelter medicine is an integral element of small animal veterinary teaching in many universities, encompassing a variety of underpinning principles of veterinary medicine (4, 5). The inherent value of teaching these topics combines the opportunity for practice and application of many aspects of small animal primary care (6). However, shelter medicine is itself increasingly recognized as independently worthy of study and practice. Student interest and engagement has been a further driver of inclusion of shelter medicine in education (7).

Worldwide, pre-registration (undergraduate) teaching in shelter medicine shows considerable differences between veterinary faculties. A lack of consensus regarding key concepts of shelter medicine within veterinary curricula could explain these inconsistencies. However, it is increasingly recognized that more inclusion of shelter medicine within veterinary education is desirable (7-9).

The concept of constructive alignment (10) sets out parameters for curriculum development that focusses on linking the teaching methods and content to what the learners need to know and be able to do. Integral to constructive alignment is the development of appropriate learning outcomes that the students should be able to achieve at the end of a period of study. Furthermore, the method of study, student activities, learning materials and assessment should be finely tuned to ensure students achieve their learning outcomes. Bloom's taxonomy of learning outcomes (11, 12) considers student activity and achievement in three domains: cognitive (knowledge), affective (attitudes) and psychomotor (skills).

The Delphi technique is a recognized method of harnessing expert opinion to reach consensus where absolute evidence is scant or lacking (13). There is a simultaneous exploration of both similarities and differences of opinion. Contributors give their opinion anonymously, which reduces the bias of other methods of collaboration and allows for parity in consideration of different ideas (14).

The Delphi technique uses a focus group to garner expert opinion on a given topic. The method collates, sorts and summarises responses to questions in a survey and re-presents this information to the contributors for further feedback, thus bringing the opinion on the subject matter to a consensus (15, 16).

Successful use of the Delphi technique has been established in various aspects of curriculum and professional development in veterinary and other medical fields (17-20). There is precedent for its use in successful development of learning outcomes in both undergraduate and postgraduate veterinary education; specifically anchoring the outcomes with sound educational principles (21, 22).

The aim of this study was to identify learning outcomes relevant to shelter medicine education using the Delphi consensus methodology.

Materials and Methods

Participants

Two groups of Delphi panel participants were recruited from the following groups:

1. Participants at a Shelter Medicine Educators Workshop, including international shelter medicine educators, held on the 23 and 24 of October 2016 in Athens, Georgia (USA). All participants in this workshop were included in Delphi Round 1, and were additionally invited to nominate one representative per institution to participate as panel members for subsequent rounds.
2. A list of veterinary educators and practitioners with an interest or expertise in shelter medicine was constructed. Charities, shelters, universities and professional organisations across Europe, Australia, Asia, Africa and North and South America were approached. They were requested to fill in a short online questionnaire describing their location, geographical area and type of expertise. Each potential participant was asked to identify further potential participants in other institutions and forward the invitation email, utilising a snowball technique for recruitment (23). Where invitations were shared across institutions, it was requested that one participant contribute per organisation to avoid over-representation. Recruitment emails were sent and reminded from August to October 2017.

Procedure

The process involved three separate sequential phases:

Delphi Round 1: Acquiring Learning Outcomes

A list of learning outcomes that were either in use in shelter medicine programs or were in course planning documents was collated from the above participants in two separate ways:

- a. Participants at the Shelter Medicine Workshop in Athens, Georgia were asked to create a list of learning outcomes (LOs) for shelter medicine practitioners, graduating veterinarians, and primary care LOs which could be taught in the shelter medicine setting. These lists were collected at the end of the workshop with consent to use them for publication in the future.
- b. An introductory email was sent to the list of shelter medicine educators and practitioners through the method identified above in September 2017. This invited them to share any existing shelter medicine teaching materials and commit to being on the panel for the Delphi.

Thus, the panellists for Delphi rounds 2 and 3 consisted of participants from the workshop and invited colleagues.

130 Analysis of original LOs

131 The initial list of learning outcomes and teaching material was discussed by the research team
132 (RD, RvdL, JS, RS and BW) and categorised in various ways:

133 As this study relates to the cognitive domain, LOs relating to practical skills were placed in a
134 list and not included in further steps. LOs deemed to be not specific or not applicable mainly
135 or solely to shelter medicine were also removed at this stage.

136 a. The remaining LOs were then analysed for repetition
137 and consolidated into composite LOs by researcher BW. These LOs
138 were then allocated to 5 separate domains which had been developed *a priori* by
139 the team, based on those previously identified in the definition of requirements for
140 shelter medicine specialist status (2). The domains were Shelter Animal Physical
141 Health; Shelter Animal Behavioural Health; Shelter Management; Public Health,
142 Community Medicine and Public Policy; and Shelter Medicine Principles.

143 Five of the researchers (RD, RvdL, BM, JS and RS) each assessed one domain for
144 the relevance the LO to the domain title. They then discussed the allocation of LOs in their
145 domain with a second researcher and the LOs were aligned to Bloom's Taxonomy through an
146 iterative discussion. If they were unable to agree about the allocation status, discussion with
147 the wider researcher group resulted in consensus and subsequent modification of the LOs.
148 The five domains were assessed throughout and adapted in an inductive, iterative process.

149 Delphi Round 2: Survey 1

150 The LOs organised by the research team were presented in an online survey format
151 (Qualtrics, Provo, UT) for all panellists. Panellists were required to select the extent to which
152 they thought each LO should be included in a shelter medicine educational program,
153 according to a 5-point Likert scale (Strongly disagree, Disagree, Neutral, Agree, Strongly
154 agree). A free text box was provided for comments or suggested amendments at the end of
155 each domain. The survey was distributed via an email invitation and link on the 9th of
156 September 2019, a reminder email sent on the 26th of September 2019 and the survey closed
157 on the 7th of October 2019.

158 All categorical data were collated in Excel. SPSS was used to produce basic descriptive
159 statistical analysis. The qualitative content was downloaded, discussed by the team and
160 informed the content of the next Delphi round.

161 Analysis of Delphi Round 2: Survey 1

162 In the absence of consistent standards for analysing data to develop consensus (16, 24) an *a*
163 *priori* consensus standard was used that required 80% or greater of the panel stating they
164 either 'strongly agreed' or 'agreed' with the inclusion of the LO in a shelter medicine
165 curriculum (24). LOs that achieved this standard were placed on the 'Accepted LO' list. For
166 some of these accepted LOs, edits were suggested, either from the Delphi panel or from the
167 research team. Where this occurred, both the original and proposed edit were
168 presented in Round 3 for panellists to choose their preferred edit.

169 Where less than 80% of panellists agreed or strongly agreed that a LO should be included, it
170 was refined and re-presented for consideration in Round 3. New learning outcomes proposed
171 in the free text comments of the Round 2 survey were discussed and developed by the
172 research team and subsequently nominated for inclusion in Round 3. These processes did not
173 significantly influence the nature of the LOs (25).

174 Delphi Round 3: Survey 2

175 A further survey was created online (Qualtrics, Provo, UT) that presented the 'Accepted LO'
176 from Round 2 back to the panellists with no further action required. Both edits of the
177 Accepted but reworded LOs were presented and panellists were asked to indicate their
178 preferred version.

179 Amended LOs with less than 80% from Round 2 and new LOs suggested in Round 2 were
180 presented and panellists were asked to rate these with the 5-point Likert scale as in Round 2.
181 Data were downloaded as previously into Excel and descriptive statistics compiled. The
182 survey was distributed via an email invitation and link on the 7th of January 2020, a reminder
183 email sent on the 24th of January 2020 and the survey closed on the 31th of January 2020.

184 Analysis of Delphi Round 3: Survey 2

185 For the accepted but reworded LOs, a greater than 50% majority agreement was used to
186 select which of the two versions to include in the 'Accepted LO' list (26). For LOs with less
187 than 80% from Round 2, and New LOs suggested in Round 2 a greater than 80% agreement
188 placed them in the final 'Accepted LO' list. LOs which did not reach greater than 80%
189 consensus in this round were rejected from the final LO list.

190 Ethical Considerations

191 All participants in the workshop, respondents to email requests for teaching material, and
192 online surveys gave permission to use their responses. This proposal was reviewed by the
193 ethics committee at the University of Nottingham School of Veterinary Medicine and Science
194 proposal # 2100 170815.

195 **Results**

196 Delphi Round 1: Acquiring Learning Outcomes

197 Forty-eight respondents initially agreed to participate in the study. Panellists were located in
198 Europe, Australia, Asia and North and South America. They described holding a variety of
199 roles, including academic, shelter practitioner and non-governmental organisations. Most
200 were involved in education of veterinary students, qualified veterinarians, or both. Some were
201 involved in education of student veterinary technicians or nurses, or of shelter staff.

202 Of these panellists, ten contributed shelter medicine teaching materials from programs in
203 Europe, Australia and the USA. These materials consisted of a mixture of course aims, course
204 materials and learning outcomes, which were rationalised and sorted as previously described
205 and organised as an online survey consisting of a total of 133 learning outcomes (Table 1).
206 These were divided across five domains:

- 207 1. Physical Health
- 208 2. Behavioral Health

3. Shelter Management
4. Public Health, Community Medicine, and Public Policy
5. Shelter Medicine Principles

Delphi Round 2: Survey 1

Thirty-three panellists responded to Survey 1. Of the 27 who specified their location, 13 were in the USA, 13 in Europe and one in Argentina. Respondents were invited to select words to describe the institutions they worked within. Common descriptors from the 27 panellists who responded included academic (17), shelter (12), non-governmental organisation (5) and government (3).

Of the proposed 133 learning outcomes, 95 were approved at >80% consensus. Of these 83 were considered complete, and 12 were re-submitted in Round 3, to allow voting on a change of wording. The 38 remaining LOs which did not reach >80% consensus in this round were modified in response to comments from panellists, condensed and re-submitted into Round 3.

	Offered in Survey 1	>80% agreement	<80% agreement	New proposed LO
Physical Health	48	41	7 *	1
Behavioral Health	22	18	4*	1
Shelter Management	22	14	8	2
Public Health, Community Medicine, and Public Policy	29	14	15*	0
Shelter Medicine Principles	12	8	4*	3
Total	133	95	38	7

Table 1: Learning outcomes offered, agreed and rejected at Survey 1 by 33 Delphi panellists. Agreement was considered achieved at >80% of panellists selecting “agree” or “strongly agree” (*Some of the LOs with <80% agreement were consolidated or split for the Delphi Round 3).

Delphi Round 3: Survey 2

Twenty-four panellists responded to Survey 2. Eight were in the USA, 15 in Europe and one in Australia. Respondents were invited to select words to describe the institutions they worked within. Common descriptors included academic (11), shelter (9), non-governmental organisation (5) and government (1).

For the second round, the twelve agreed LOs that had had their wording queried were given to the panel with both original wording and an amended version. Two original learning outcomes were identified as containing duplication, so were offered condensed into one. All the resulting twelve amended versions were accepted as preferred to the originals.

The 38 learning outcomes which did not reach consensus in Round 1 were condensed into 34 LOs, re-worded in response to comments from the panellists and re-presented. Of these, 4 reached 80% consensus and were accepted, while the remaining 30 did not reach agreement. Therefore these 30 were removed from the final list of agreed LOs for a shelter medicine curriculum.

Seven new learning outcomes were proposed by the panellists following Round 2 and submitted for Round 2. Of these, three reached consensus at >80% and were included in the final list, and five did not reach consensus. This resulted in a final list of 102 agreed LOs. The final agreed and excluded LOs are presented in Tables 3 and 4.

	>80% agreement unchanged	> 80% agreement, changes proposed (changes accepted at >50%)	<80% agreement from round 1 (accepted at >80% round 2)	New proposed LO from round 1 (accepted)	Total
Physical Health	39	2 (2)	5 (0)	1 (1)	42
Behavioral Health	17	1 (1)	4 (1)	1 (1)	20
Shelter Management	13	1 (1)	8 (1)	2 (0)	15
Public Health, Community Medicine, and Public Policy	11	3 (3)	15 (2)	0	16
Shelter Medicine Principles	3	5 (5)	2 (0)	3 (1)	9
Total	83	12 (12)	34 (4)	7 (3)	102

Table 2: Learning outcomes agreed, modified and rejected in Round 2 by 24 Delphi participants. All learning outcomes were included at >80% agreement. Where participants were invited to choose between original and amended wording, >50% agreement was used as the threshold for selection.

Physical Health

<i>Overarching Principles</i>
Identify the differences between population and individual animal medicine and the points where they may conflict.
Design and analyze preventative health care protocols to minimize the risk of shelter-acquired disease and prepare animals for a timely outcome.
Assess physical and behavioral health and management of overall population.
Design procedures for animal intake including initial assessment, preventative health care, and urgent care.
Utilize evidence-based medicine to determine an optimal treatment plans for individual animals including costs, staff training, resources, and other constraints and understand why an optimal plan does not always mean reported “gold standard” in practice.
Describe the importance of evidence-based decision making in the shelter setting.
Create adoption releases and protocols that allow clear communication and expectations regarding the animals’ health and needs.
Demonstrate understanding and knowledge of pathophysiology, risk factors, clinical signs and diagnosis of infectious diseases common in the shelter environment.
<i>General Medicine</i>
Create appropriate treatment plans for shelter animals that take into context the mission and resources of the shelter.
Diagnose and treat common conditions found in shelter animals.
Assess physical and behavioral health of individuals and formulate a plan for short- and long-term interventions and long-term prognosis.
Demonstrate proficiency in taking a history in the shelter setting and creating a problem list most effective for approach and diseases in the shelter.
Devise treatment options for patients including different pain management protocols and considerations for time for treatment.
Conduct medical rounds in a shelter setting identifying, treating, and monitoring animals for response to treatment.
Justify treatment plans and protocols using evidence and appropriate logic.
<i>Surgery</i>
Describe pros and cons of spay and neuter from a medical, behavioral, and population-based perspective.
Demonstrate proficiency in shelter surgical and anaesthetic procedures including sterilizations and paediatric spay and neuter utilizing appropriate asepsis and tissue handling.
Describe different surgical techniques and options and compare to the evidence in the literature such as pedicle ties, scrotal neuters, miller’s knots, etc.
Devise and utilise appropriate and humane multimodal analgesia protocols for routine surgeries.
<i>Infectious Diseases and Outbreaks</i>
Synthesize information regarding appropriate vaccine handling and protocols and apply in the shelter environment.
Create a plan for outbreak management for various types of diseases in the context of a particular shelter’s resources and discuss implications of staffing, training, and oversight.
Recognize and respond to common infectious diseases in the shelter including isolation and quarantine.
Identify elements relevant for evaluating infectious disease risks.

Evaluate aspects of the population, husbandry and biosecurity likely to be important in affecting the risk of infectious diseases in individuals and in the population.
Demonstrate the uses and limitations of diagnostic tests, including concepts such as sensitivity, specificity and predictive value.
Understand how properties of a pathogen affect its potential routes of transmission.
Describe the place of management strategies such as foster care in infectious disease prevention.
Utilise appropriate handling, anesthetic, surgical and post-operative management practices for surgical neutering of free roaming animals being returned to their habitat.
<i>Euthanasia</i>
Recognize methods, laws, guidelines, and management surrounding euthanasia and how to create a humane plan for a patient to provide euthanasia in a timely fashion.
Describe appropriate practices for humane shelter animal euthanasia including proper training, staff, and procedures and describe the regulations surrounding this practice.
Explain how different euthanasia policies may affect decision making in the shelter environment.
Discuss euthanasia decisions in the context of multiple stakeholders with different opinions.
<i>Standards and Assessments</i>
Read and utilize the ASV Guidelines for Standards of Care in Animal Shelters
Identify other online resources that can be utilized by shelter veterinarians.
Identify spay and neuter training programs and research regarding the practice.
<i>Sanitation and Biosecurity</i>
Review protocols for cleaning and sanitation that take into consideration the population and specific disease risks such as parvovirus or ringworm.
Recognize zoonotic diseases, discuss risks to animals and people and develop risk management plan.
Use appropriate personal protective equipment and biosecurity principles when conducting examinations.
Describe any specific local regulations related to common zoonotic diseases such as notifiable or occupational diseases.
<i>Facility and Housing Design</i>
Discuss housing recommendations for individual animals based on consideration of species, age, health, intake status, and behavior.
Discuss the role that housing and shelter design plays in animal health and welfare in a shelter setting, including preferred types of housing, space allocation recommendations, and impacts of appropriate versus inappropriate housing on animal health, welfare, and live release.
Describe how facility design and housing can reduce stress in animals' disease transmission, protect behavioral and mental well-being, and increase efficiency for staff.
Behavioral Health
<i>Overarching Principles</i>
Describe and interpret feline and canine body language.
Discuss the factors that influence an animal's behavior.
Distinguish different professional roles and accreditations in behavioral intervention including shelter veterinarian, veterinary behaviorist, clinical behaviorist, and trainer.
Describe the relationship between stress and disease.

Determine protocols for reducing stress and promoting positive welfare.
Evaluate and prioritise the sometimes-conflicting welfare needs of an animal in a shelter (behavioral and physical health, short term vs long term welfare, individual vs population).
<i>Population Behavioral Health</i>
Assess the impact of housing and environment on behavior and welfare.
Use appropriate behavioral and welfare information to make appropriate outcome and placement decisions within various sheltering models including discussion of humane euthanasia and public safety.
Determine strategies to improve individual and population behavioral health and welfare and describe the advantages and limitations of each.
Identify opportunities to promote good behavioral health including socialisation and learning, recognising sensitive periods for behavioral development, behaviorally sensitive handling, appropriate environment, and training techniques.
<i>Individual Animal Behavioral/Psychological Health</i>
Discuss available methods and tools for behavioral interventions in a clinical setting in the context of resources within a shelter.
Discuss the benefits and limitations of tools and methods for assessing behavior.
Discuss the methods and tools for assessing behavioral health as an element of quality of life assessment.
Participate in behavioral modification, enrichment, and socialization for shelter animals.
Create plans for behavioral wellness and treatment for individual shelter animals including specific enrichment, management, training, behavioral modification, medication, rehoming, and education strategies.
Demonstrate methods of low stress handling including maximizing animal and handler safety and minimizing overall stress.
Discuss, and as appropriate select, medication that may be used as short-term (e.g. sedatives) and long-term (e.g. psychopharmacological) intervention to ensure handler safety and aid in the management of behavioral problems in the shelter.
Apply the principles of behavioral first aid to ensure handler safety and avoid worsening problem behaviors.
Determine appropriate immediate intervention for a behavior problem to ensure handler safety and avoid worsening problem behaviors.
Contribute to the development of shelter animal behavior and welfare diagnostic and treatment plans using a problem-oriented approach that maximize behavioral health while minimizing impact to physical health.
Shelter Management
<i>Understanding Companion Animal Homelessness in Context</i>
Discuss drivers for pet acquisition, retention, and relinquishment dynamics and risk factors for animal homelessness.
Assess potential in-community risk factors for animal homelessness.
<i>Options for Care</i>
Describe the role of the veterinary professional in animal sheltering organisations.
List the laws applying to animal sheltering in your community and evaluate their impact on different shelters types.
Describe programs designed to maximize shelter live release rates including managed intake, alternatives to admission, removing barriers to adoption, redemption facilitation, rescue/transfer programs, return to field, open selection, owner requested euthanasia, etc.

Describe the considerations of transport programs and discuss guidelines and use of 'best practice' in different contexts.
<i>Care of Shelter Staff</i>
Discuss how shelter administration can support shelter staff who are at risk for compassion stress and fatigue.
Discuss stakeholder priorities in the shelter including management, volunteers, public, staff, and veterinarians.
<i>Monitoring and Evaluation</i>
Describe the different ways that animals enter and leave the shelter facility.
Describe the concept of capacity of care and apply in the context of different shelter facilities.
Identify methods of measurement and evaluation for assessing programmatic success of interventions.
Recognize the importance of animal flow and length of stay and their impact on different shelters' 'capacity of care'.
Discuss the format of general operations and flow through and execute pathway planning to decrease length of stay and promote live outcomes.
Interpret statistics commonly used to describe shelter population dynamics, assess the availability of this data at different shelters, and apply to procedural recommendations or interventions.
<i>Emergency, Outbreak and Disaster Response</i>
Describe different principles of emergency and disaster response.
Public Health, Community Medicine, and Public Policy
<i>Animals and Public Policy</i>
Perform welfare assessment of animals, especially within the shelter setting.
Describe the role of shelters and veterinarians in investigating, resolving, and providing care for animal affected by cruelty, neglect, and hoarding and interfacing with human agencies to provide comprehensive and effective interventions.
Describe the management techniques, literature, and pros and cons of different approaches to different types of stray/feral populations of domesticated animals.
Describe different types of programs to prevent relinquishment to shelters including safety net programs and accessible car.
Describe and apply the five welfare needs in a shelter setting and discuss the concept of positive welfare and a good life, beyond the five welfare needs.
<i>Public Health</i>
Discuss concepts of zoonotic disease and responsibility of the shelter to prevent their spread, considering the shelter as a workspace and a public place to visit/acquire pets.
Apply prevention techniques to avoid physical harm in humans when handling animals (dog bites, cat bites/scratches, etc).
Describe risks to staff engaged in shelter or community medicine and how to prevent exposure of disease particularly to high-risk groups.
Demonstrate knowledge of national legislation and regulations pertaining animal sheltering and welfare, use of disinfectants and zoonotic diseases.
Describe knowledge of legal rules and regulations pertaining to reportable diseases.
<i>Animal Cruelty and Investigations</i>
Describe how to recognize animal cruelty and describe the role of the veterinarian.

Investigate how to find laws for your area for animal cruelty and the role of the veterinarian.
Develop plans for an animal hoarding situation including an understanding of implications of different types of interventions on the owner and management of the individual animals.
Be familiar with the scientific literature on forensics of animal abuse.
Describe the link between domestic violence and animal abuse, and how to engage with humane investigations.
<i>History</i>
Discuss overall trends in stray populations and provide examples of historical interventions (failures and successes) and interpret recent trends surrounding these issues.
Shelter Medicine Principles
<i>Communication</i>
Summarise the key concepts of shelter medicine to veterinarians in other disciplines.
Demonstrate tolerance for conflicting ideas and an openness and flexibility to accept change.
Develop communication skills that develop good relationships with team members, pet owners & fosterers, including cultural sensitivity, compassion, respect, and the importance of prioritising the human animal bond and animal welfare.
Recognize personal bias and develop skills to productively discuss difficult or controversial topics.
Recognize the challenges of working in a multidisciplinary team in a calm and collaborative manner whilst prioritising animal health and welfare.
Recognize employment opportunities that exist for veterinarians in shelters and discuss the types of experience and perspective needed for success in the positions.
<i>Ethics</i>
Recognize responsibility for the welfare of the community and advocate for the ethical principles of the field.
Define common ethical approaches and their impact in decision making in animal welfare.
<i>Evidence-Based Veterinary Medicine</i>
Appraise evidence and apply the EBVM approach in both individual and population management strategic decisions, protocols and procedures.

Table 3: Learning outcomes accepted at >80% agreement during the Delphi process.

Physical Health
Formulate a clinical research question, perform a literature search and evaluate the evidence obtained.
Describe and utilize principles of antimicrobial stewardship and articulate why lack of resources does not justify inappropriate use of antimicrobials.
Describe husbandry and basic management of exotic, wildlife and farm species including legal and ethical restrictions on treatment.
Discuss principles and methods of necropsy, tissue handling and collection of diagnostic samples.
Evaluate HQHVSN (High quality high volume spay and neuter) programs for efficacy in addressing community need, efficiency in utilization of resources, and adherence to Veterinary Medical Care. Guidelines for Spay Neuter Programs
Behavioral Health
Explain the underlying learning theory (including classical and operant conditioning, habituation, counterconditioning and desensitisation) used in behavioural modification techniques.
Compare the use of reward-based training, and training that applies punishment.
Create a behavioral plan for shelter animal in the home including communication with the adopter or fosterer about how to manage it.
Shelter Management
Describe the organisation of different types of animal shelters, including non-profit, animal control or other government entities.
Compare the mission, community and wider impact and resources of the different shelter organisations.
Describe a typical management structure in an animal shelter organisation.
Examine needs for training of shelter and veterinary staff, adopters, and volunteers.
Interpret raw shelter data and identify complicating factors for collection, retrieval, and analysis.
Investigate shelter level hypotheses and research using relevant shelter data and interpretations.
Propose resource reallocation needed in an outbreak situation
Recognize the need for appropriate work-life balance strategies supporting shelter staff wellbeing.
Discuss the veterinary implications of developing pet friendly housing.
Public Health, Community Medicine, and Public Policy
Discuss cultural and legal differences in animal management locally, nationally, and internationally and identify how general shelter concepts can be applied effectively in these settings.
Create a productive plan for advocating for animals within organizations and communities.
Recognize the features of the human animal bond and how it impacts people in the community and through the shelter.
Describe animal bite prevention programs.
Develop skills to identify and respond to emerging diseases including a surveillance plan for reportable diseases

Understand basic disaster preparedness and response concepts.
Engage in one-health concepts and organization and coordination with human and environmental interventions.
Discuss impact of different types of trade (meat trade, live markets, etc.) on animal welfare and public health and complicating importance in other cultural contexts.
Define and interpret common epidemiologic and statistical terms including incidence, prevalence, rate, odds, risk, relative risk, etc.
Recognize the importance and diversity of the human animal bond.
Recognize the link between animal cruelty and interpersonal violence.
Describe the possible roles a veterinarian can play in humane investigations.
Complete a SWOT (strengths, weaknesses, opportunities, threats) analysis of the shelter's current position / progress in relation to historical trends.
Shelter Medicine Principles
Design, rationalise and communicate possible treatment plans including recording of concise clinical notes.
Develop appropriate techniques for communication within the shelter including facilitating teamwork.
Work effectively as part of a veterinary team demonstrating calm and collaborative behavior.
Discuss the role of the veterinarian in complex decision making e.g. depopulation, treatment of the population versus the individual and confinement.
Discuss the use in shelter medicine of some of the basic frameworks for understanding and instigating human behaviour change.

Table 4: Learning outcomes not accepted following Round 3.

Discussion

This study has utilised a consensus-based Delphi approach to identify and refine learning outcomes which are relevant to shelter medicine education worldwide. This represents an evidence-based approach to developing this nascent discipline with a grounded, inductive strategy. The resulting learning outcomes can serve as a tool for those developing veterinary curricula for academic programming relevant to all graduates (27). It has been suggested that involving more veterinarians in shelter medicine, and equipping them with the tools to practice this discipline has the potential for an enormous positive impact on animal welfare (2, 8, 9, 28).

These learning outcomes will be relevant both as a foundation to those intent on a career in shelter medicine, and to the many veterinarians entering into primary care practice where shelter medicine will form a component of their work. Although it was initially envisioned that the LOs identified would be further stratified via those relevant to pre- and post-registration (i.e. pre- and post-qualification to practice), as has been previously carried out in comparable contexts (21, 22), in practice this was not pursued, due to the worldwide variation in perception of the role of shelter medicine. Whilst the number of finalised LOs is similar to that in previous studies (22), it is unlikely that any single curriculum will encompass all of them. Instead, this is intended as a resource which can be used to build curricula as locally appropriate. This could include both stand-alone shelter medicine teaching, and also the use of shelter medicine in teaching of wider and more diverse concepts, such as biosecurity, ethics and epidemiology. Similarly, although the LOs have been categorised within five

domains, there is arguably overlap between those areas, and as this document is used and evolved it may be appropriate to reassign LOs to different domains.

Reasons why the excluded LOs were rejected are unknown. Although free text comments were invited, these were relatively sparse, and no formal analysis was therefore appropriate. However, indications that some LOs were felt to be either covered elsewhere or less universally relevant were noted. Concepts such as HQHVSN (High Quality High Volume Spay Neuter) may simply have been less familiar terminology to some respondents and therefore judged to have been of less importance. Alternatively, legal regulation restricting the participation of shelter veterinarians in pet neutering could have influenced the inclusion of some LOs. The definition of the scope of shelter medicine may vary in different locations. For example, in the UK, there is a longstanding and extensive tradition of charity practice, which is considered as allied with shelter medicine (29). This is not universally the case outside the UK, where low-cost and charitable care are less prevalent.

Nonetheless, these excluded LOs could still be critical to shelter medicine curriculum development in specific countries. Shelter medicine educators utilizing these resources should feel empowered to include and interpret them in the context of their own needs. Additionally, within this context, the LOs were focussed on the cognitive domain of Bloom's taxonomy, and those deemed highly focussed on affective or psychomotor domains were excluded (with the exception of two LOs considered by the authors to be fundamental to shelter medicine, and unlikely to be seen elsewhere). This decision was made due to the extensive crossover with primary care which these represented; however, this highlights an area for future exploration.

Additionally, further discussion regarding the value of defining learning outcomes for first-day skills learned through shelter medicine and learning outcomes for shelter specialists is warranted. This was initially intended to be part of the present study. However, through the process of this research, considerable geographical variation emerged concerning whether specific skills and learning outcomes were regarded as appropriate to pre-registration education, and which were more specialised. It is possible this reflects aspects of veterinary education (which is a primary degree in the UK but postgraduate in the USA and elsewhere). It may also be influenced by well as how integrated shelter medicine is into general practice, and its stage of development as a distinct specialty, in different locations. In the light of this, it was considered that developing a core list of Shelter Medicine LOs should be considered an essential first step. As shelter medicine continues to develop as a specialty in more areas across the world, the need for consideration of universal international learning outcomes at the specialty level would be especially helpful.

Limitations

Participants were included based on self-identification as a shelter medicine educator. The United States is the only country that so far has a recognized veterinary specialty in shelter medicine and therefore, given the international nature of this study, panellists were drawn from a variety of unstandardized contexts within veterinary shelter medicine education. This strategy was chosen in order to represent as broadly as possible the scenarios in which these LOs might later be utilised. This is consistent with similar Delphi exercises in which expert status has been defined by being embedded within the practice being explored (20, 25, 30). Although the geographical spread of the panellists initially recruited was relatively diverse,

the eventual participants were very heavily skewed towards Europe and the USA. It is likely that this affected the final choice of learning outcomes. It is possible that providing the surveys in languages other than English may have helped capture more diverse opinions; however, this was not considered logistically feasible within the constraints of the project. Similar studies have utilised a formal thematic analysis in order to incorporate free text comments into shaping learning outcomes (21, 31). In this study, free text responses were scant, and therefore panellists' comments were discussed among the research team and utilised in a less formalised manner.

The Delphi methodology is described in the literature as a tool to generate discussion (13). It is recognized for its democracy and its scope in reaching a consensus, and for harnessing expertise in the face of logistical challenges such as geographical spread (16). The final LO list is intended to establish foundations of the ever-developing shelter medicine field within the curriculum. This study has documented the panellists' areas of interest and honed the list of learning outcomes, all at different levels of Bloom's taxonomy, covering many facets of this new discipline. The learning outcomes generated are intended as a resource to be utilised, shared, developed and adapted, and should not be regarded as a final pronouncement, but instead a foundation for the basis of continued re-evaluation and re-development.

Conclusion

A set of LOs, developed and evaluated by agreement by shelter medicine educators internationally has now been collated and can be used to embed shelter medicine teaching within pre-registration curricula worldwide. The LOs can be adapted in any educational setting in any country with confidence that colleagues believe the subject material to be of value. Shelter medicine can be taught alongside and integrated with other disciplines to help enhance the field and further develop the practice of cross-cutting themes. This international study has emphasised the breadth and depth of this important discipline, which is of value and necessary in its own right, and not simply an addendum.

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